Research in Autism Spectrum Disorders 25 (2016) 24–36

Contents lists available at ScienceDirect

Research in Autism Spectrum Disorders

journal homepage: http://ees.elsevier.com/RASD/default.asp

Gaze patterns during scene processing in typical adults and adults with autism spectrum disorders

Sarah N. Rigby[a], Brenda M. Stoesz[a,b], Lorna S. Jakobson[a,*]

[a] Department of Psychology, University of Manitoba, 190 Dysart Road, R3T 2N2 Winnipeg, Manitoba, Canada
[b] The Centre for the Advancement of Teaching and Learning, University of Manitoba, 183 Dafoe Road, R3T 2N2 Winnipeg, Manitoba, Canada

ARTICLE INFO

Article history:
Received 12 September 2015
Received in revised form 31 January 2016
Accepted 31 January 2016
Available online 9 February 2016

Keywords:
Adults
Autism spectrum disorder
Dynamic face processing
Eye-tracking
Selective attention

ABSTRACT

Background: Little is known about how adults with autism spectrum disorder (ASD) process dynamic social scenes.
Method: We studied gaze behavior in 16 adults with ASD without intellectual impairment and 16 sex- and age-matched controls during passive scene processing.
Results: Adding more characters to a scene resulted in a drop in time spent looking at *faces*, and an increase in time spent looking at *bodies* (static trials) or *off-person* (dynamic trials) [Scene Type × AOI × Mode: $F(2, 60) = 3.54$, $p = .04$, $\eta^2_p = .11$]. Unlike controls, adults with ASD showed only a small drop in the number of fixations made [Mode × Group: $F(1, 30) = 11.30$, $p = .002$, $\eta^2_p = .27$] and no increase in the duration of face fixations [Mode × AOI × Group: $F(2, 60) = 3.50$, $p = .04$, $\eta^2_p = .11$] when dynamic cues were added. Thus, particularly during dynamic trials, adults with ASD spent less time looking at faces and slightly more time looking off-person than did controls [Mode × AOI × Group: $F(2, 60) = 3.10$ $p = .05$, $\eta^2_p = .09$]. Exhibiting more autistic traits and being less empathic were both associated with spending less time fixating on faces [$.34 < |r| < .55$, $p < .05$].
Conclusions: These results suggest that adults with ASD may be less sensitive to, or have more difficulty processing, dynamic cues—particularly those conveyed in faces. The findings demonstrate the importance of using dynamic displays in studies involving this clinical population.

1. Introduction

Autism spectrum disorder (ASD) is a condition characterized by deficits in social communication and interaction, and by restricted and repetitive interests or behaviors (American Psychiatric Association, 2013). Some of the social difficulties experienced by people with ASD have been suggested to arise, in part, from deficits in face processing (e.g., Baron-Cohen, 1995; Remington, Campbell, & Swettenham, 2011; Senju, 2013). It is important to note, however, that most of the existing research exploring face processing – both in typical viewers (see O'Toole, Roark, & Abdi, 2002 for a review) and in viewers on the autism spectrum (e.g., Riby, Doherty-Sneddon, & Bruce, 2009) – has involved the use of static stimuli. In order to gain an accurate picture of the factors that contribute to social deficits in ASD, it is essential to extend this work with studies that incorporate naturalistic facial stimuli, particularly in light of recent behavioral evidence suggesting that people process

* Corresponding author. Fax: +1 2044747599.
E-mail addresses: umrigby@myumanitoba.ca (S.N. Rigby), Brenda.Stoesz@umanitoba.ca (B.M. Stoesz), Lorna.Jakobson@umanitoba.ca (L.S. Jakobson).

http://dx.doi.org/10.1016/j.rasd.2016.01.012

moving and static faces differently (e.g., Chiller-Glaus, Schwaninger, Hofer, Kleiner, & Knappmeyer, 2011; Hill and Johnston, 2001; Pilz, Thornton, & Bülthoff, 2006; Stoesz & Jakobson, 2013, 2014).

In recent years, researchers have used eye-tracking technology to explore differences in how viewers attend to faces presented in static and dynamic scenes. The results of these studies have generally suggested that typical individuals are biased to attend to *faces* rather than to other aspects of static displays (e.g., Remington et al., 2011), but that adding motion (e.g., O'Toole et al., 2011) or adding more characters to a scene (Stoesz and Jakobson, 2014) causes them to shift their attention from faces to bodies, or off-screen. Stoesz and Jakobson (2014) showed that the effect of the latter manipulation was more dramatic in children than in adults. They also showed that children made fewer fixations on dynamic faces than adults did, and showed a larger increase in mean fixation duration after the addition of dynamic cues. This is of interest as adjustments such as these can reflect more effortful processing (Holmqvist et al., 2011). Together, these observations are consistent with the idea that children generally find the processing of faces in dynamic and/or socially complex scenes more challenging than adults do.

Several recent observations suggest that adding naturalistic facial motion and increasing the social complexity of scenes affects the gaze behaviors of children with ASD even *more* than the gaze behaviors of typical children. For example, Riby and Hancock (2009) observed that children with ASD spent more time than controls looking at backgrounds than at faces when viewing dynamic human action sequences, but not when viewing cartoon pictures. These authors concluded that group differences in gaze behaviors are most apparent in realistic viewing conditions, and that the increased complexity of dynamic displays functions to either distract or overload attention in individuals with ASD. Rice, Moriuchi, Jones, and Klin (2012) found that, compared to typical controls, children with ASD spent more time looking at bodies and inanimate objects, and made fewer fixations on faces, when they were viewing dynamic social scenes passively. Others have reported that children with ASD spend less time fixating on the eyes and more time fixating on bodies than controls when viewing dynamic multiple-character scenes, but not when viewing static single-character scenes (Speer, Cook, McMahon, & Clark, 2007).

The first purpose of the present study was to determine if some of the findings reported above could be replicated in adults with ASD. To that end, we tracked the eye movements of adults with ASD and of typical controls as they passively viewed static and dynamic, single- and multiple-character scenes. We expected that introducing movement and additional characters to a scene would affect the gaze behaviors of both groups, but that adults with ASD might show a pattern of gaze behaviors similar to that described in children with this disorder. Specifically, we hypothesized that viewers with ASD would spend less time looking at faces and more time fixating on bodies than controls, particularly when viewing dynamic multiple-character scenes. This pattern of results would support the view that problems in attending to salient social cues persist into adulthood in people with ASD. We extended earlier work by determining whether such group differences, if present, reflected changes in the number and/or the duration of fixations made on faces, which would allow us to characterize changes in gaze behavior more fully.

ASD is a spectrum disorder. If problems with social perception (including those affecting attention to facial cues) contribute to symptom severity, these problems may be most evident in those who display the largest number of autistic traits. In support of this hypothesis, Ingersoll (2010) showed that, in a large sample of university students, participants who endorsed more autistic traits made more errors on a face recognition task. Another study examining autistic characteristics in the general population found that traits associated with the broad autism phenotype were related to impairment in social cognition (Sasson, Nowlin, & Pinkham, 2012). Given these findings, the second major goal of the present study was to assess the strength of associations between attentiveness to faces during passive scene perception and the autistic traits of participants in our full sample.

Finally, we wanted to study the relationship between attentiveness to faces and self-reported levels of empathy. The link between social perception and empathy is interesting, given that people with ASD exhibit difficulties with cognitive empathy (the ability to take another's perspective or understand the reasons for their behavior) (Dziobek et al., 2008; Lockwood, Bird, Bridge, & Viding, 2013) [note that results for affective empathy, the ability to feel another's emotions, are more mixed (Dziobek et al., 2008; Mazza et al., 2014)]. Recently, it has been reported that individual differences in face-specific event-related potentials are related to both the number of autistic features and the level of empathy that typical viewers display (Lazar, Evans, Myers, Moreno-De Luca, & Moore, 2014). Moreover, empathizing with emotive faces by appraising the emotions expressed activates social networks in the brain (Schülte-Ruther, Markowitsch, Fink, & Piefke, 2007). In typical viewers, there is also a relationship between empathy and the ability to detect faces quickly, and those who exhibit higher affective empathy make more and longer fixations in particular areas of static faces, depending on the emotion displayed (Balconi and Canavesio, 2014). In the present investigation, we anticipated that viewers who self-reported higher levels of empathy would also be more attentive to faces during passive scene processing.

2. Methods

2.1. Participants

We tested 16 adults with ASD (11 men, 5 women), all of whom had received a formal diagnosis of ASD or Asperger's disorder from a physician, psychologist, or psychiatrist, which was validated prior to participation by a qualified, independent practitioner. Each individual with ASD was matched to a typical participant of the same sex and age (±2 years).